Final Report from 2017 NPB Funding

I. Subject area: Molecular Genetics & Breeding

a. Project Title: Molecular and Conventional Breeding to Increase Peanut Yields and Production Efficiency by Developing Breeding Lines with Improved Drought and Heat Tolerance combined with Multiple Disease Resistance

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c. Co-PIs:

Mark D. Burow, Professor, Texas A&M AgriLife REC, Lubbock, 79403; and Dept. of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409. mburow@tamu.edu

Michael R. Baring, Assistant Research Scientist, Dept. of Soil and Crop Sciences Dept. Texas A&M University College Station, TX. 77843. m-baring@tamu.edu

Charles E. Simpson, Professor Emeritus, Texas A&M AgriLife REC, Stephenville, TX 76401. c-simpson@tamu.edu

Paxton Payton, Research Plant Physiologist, 3810 4th Street, Lubbock, TX, 79415; Adjunct Assistant Professor, Dept. of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409. paxton.payton@ars.usda.gov

Proposal Coordinator:

Michael R. Baring, Dept. of Soil and Crop Sciences, Texas A&M AgriLife Research, College Station, TX. 77843-2474, m-baring@tamu.edu
Phone: 979-220-2656

Sub-Project I. Multiple Location Replicated Yield Trials

1. Multiple Disease Resistant Runner Trials:

We planted 6 locations of our most advanced materials in terms of multiple disease resistant runner-types in 2017. One location on a cooperators field in Dilley, Texas was not harvested due to deer and animal damage. We had 16 advanced lines and 4 commercial checks in these trials. Data for these lines and checks are shown in **Table 1**.

Three breeding lines (Tx144370, Tx144485, and Tx144342) are high oleic, and have resistance to Rootknot nematodes as does the commercial check Georgia 14N. These three lines were of particular interest because they performed well in the 2016 yield trials. Five breeding lines performed in the top statistical grouping for yield and value with Tx144370 having the highest yield at 6223 lbs/A. Georgia 14N was nearly identical with a yield of 6210 lbs/A followed closely by Tx144485 at 6194 lbs/A. Tx144342 performed in the top grouping, but further down the list with a yield of 5791 lbs/A. It has performed consistently at the top of the test over the past two years. Georgia 14N had the highest mean grade in the test at 77.5%.

While Tx144370 and Tx144485 were not in the top grouping for %TSMK, they still managed to perform in the top grouping for value/a because of their high yield potential. All three of the breeding lines shown on this table are being considered as a potential release candidate to replace the Webb variety as they have performed superior to Webb over a three year period of yield testing. Breeding lines Tx144370 and Tx144342 typically grade 2-3% higher than Webb, have smaller seed size than Webb, and a much shorter growth habit than the Webb variety which are all desirable traits. While there was no significant difference between these two breeding lines and the Webb variety for yield in 2017, previous trials have indicated that they will yield 300-500 lbs/A higher than Webb.

Table 1. Combined Analysis of Advanced Line Yield Trials across Texas in 2017.

Entry	Lbs./A	Value$/A	%TSMK	g/100 sd.
Tx144370	6223a	1135ab	74.2d-g	70.6fg
Georgia 14N	6210a	1184a	77.5a	66.7h
Tx144485	6194ab	1136ab	74.2d-g	81.1a
Tx144521	6092ab	1103a-c	73.7e-i	73.9de
Tx144506	6046a-c	1083bc	72.7ij	62.3i
TxL080243-06	6006a-c	1091a-d	73.4g-i	74.6d
Tx121082	6006a-c	1118a-c	75.5bc	78.5bc
Webb	6003a-c	1079bc	73.1hi	78.5bc
Tx144484	5897a-c	1070bc	73.8e-i	73.6de
Tx144507	5892a-c	1042b-d	71.8j	63.7i
Tx144367	5851a-d	1062b-d	73.6f-i	71.1f
Tx144342	5791a-d	1059b-d	74.3c-g	78.7a-c
Georgia 09B	5791a-d	1065b-d	74.8c-e	68.2gh
Tamrun OL11	5779a-d	1089a-c	72.6b	72.4d-f
Tx144429	5740a-d	1062b-d	75.1b-d	72.0ef
Tx144509	5704b-d	1050b-d	74.7c-f	80.5ab
Tx121032	5568c-e	1024d-e	74.4c-g	77.3c
Tx144431	5372de	972de	73.5f-i	72.9d-f
Tx144511	5157e	943e	73.8e-i	62.8i
Tx144421	5090e	940e	74.7c-f	81.0a
P-value (≤0.05)	≤0.0001	≤0.0001	≤0.0001	≤0.0001

Values followed by the same letter are not significantly different using Fisher's LSD at ($p \leq 0.05$).

We began a small seed increase of the Tx144342 breeding line in 2018 in anticipation of a possible release, but we have continued testing of many of these lines in multiple location trials for 2018 to acquire more data before making a final decision on a release. Both of the lines mentioned above have performed better over the past three years than Webb in terms of overall yield, value, and %TSMK as well as having a more desirable seed size and vine size.

2. Initial Drought Tolerant Yield Trials

This was the second year of replicated yield trials in South Texas for a group of 80 drought tolerant breeding lines. These lines were tested under drought stress in West Texas and under full irrigation in South Texas to see how they would perform under normal conditions. We conducted a Drought #1 test with 30 entries, a Drought #2 test with 30 entries, and a Drought #3

test with 20 entries at Pearsall, Texas. Test plots were 2-row and planted to a length of 10 feet with a 5 foot alley between ranges. The vines grew so large that they lapped in the middle of the 5 foot alley. It should be noted that we believe yields are exaggerated due to the end of the row effect where the vines grew out past the original planting point but that the yields are all relative when compared to the parental checks.

In the Drought #1 test, six lines performed in the top statistical grouping for yield (**Table 2**). Breeding line TxL100212-03-03 had the top yield of 7496 lbs/a which was significantly better than either parent, Tamrun OL11 (5891 lbs/A) or ICGS-76 (5960 lbs/A).

Table 2. South Texas Drought #1 Yield Trial in 2017.

Entry	Lbs/A	Value$/A	%TSMK
TxL100212-03-03	7496a	1401a	76.0a-d
TxL100212-05-03	6940ab	1288a-c	75.2b-e
TxL100212-03-06	6815ab	1303ab	78.1a
TxL100212-03-08	6614a-c	1239a-d	76.1a-c
TxL100212-05-01	6614a-c	1179b-f	72.3g-j
TxL100212-05-02	6561a-c	1200a-e	74.2c-h
TxL100212-03-09	6412b-d	1180b-f	74.6c-f
TxL100212-03-12	6404b-d	1205a-e	76.3a-c
TxL100212-03-13	6305b-e	1168b-f	75.2b-d
TxL100212-05-06	6292b-e	1160b-g	74.6c-f
TxL100212-03-11	6117b-f	1120b-h	74.3c-g
ICGS-76	5960b-f	1117b-i	76.2a-c
TxL100212-02-05	5900b-f	1067d-j	72.9f-j
TxL100212-03-05	5900b-f	1084c-j	74.4c-g
Tamrun OL11	5891b-f	1120b-h	77.1ab
TxL100212-03-01	5882b-e	1088c-j	75.1b-e
TxL100212-04-02R	5874b-e	1006e-k	69.1l
TxL100212-03-10	5686c-g	1047d-j	74.7c-f
TxL100212-04-07	5634c-g	1049d-j	75.3b-e
TxL100212-02-06	5632c-g	1015e-k	72.6f-j
TxL100212-02-02	5417d-h	986f-k	73.7e-i
TxL100212-02-07	5364d-h	961g-l	72.6f-j
TxL100212-02-08	5358d-h	982f-k	73.9d-i
TxL100212-02-01	5290e-h	940h-l	71.4jk
TxL100212-02-10	5146f-h	912i-l	71.1j-l
TxL100212-02-09	5124f-h	908j-l	71.9ij
TxL100212-02-04	5116f-h	908j-l	71.5jk
TxL100212-04-02B	4677gh	838kl	72.1h-j
TxL100212-02-03	4401h	763lm	69.5kl
TxL100212-04-03	3294i	613m	75.3b-e
P-value (≤0.05)	≤0.0001	≤0.0001	≤0.0001

Values followed by the same letter are not significantly different using Fisher's LSD at ($p \leq 0.05$).

TxL100212-03-03 also topped the test with the highest value/a at 1401$/A. Five out of the six breeding lines performed in the top grouping for value/A with TxL100212-05-01 performing out of the top group for value because it had a lower %TSMK of 72.3%. Breeding line TxL100212-03-06 had the highest grade at 78.1%. All of these numbers are promising considering that they performed equal to or better than the parental checks. They are being tested again in 2018 at a field near the 2017 location.

There were eleven breeding lines in the Drought #2 Trial that performed in the top grouping for yield (**Table 3**).

Table 3. South Texas Drought #2 Yield Trial in 2017.

Entry	Lbs/A	Value$/A	%TSMK
TxL100225-03-13	6914a	1257ns	73.9ns
TxL100212-07-08	6124ab	1101	75.2
TxL100212-05-09	6115ab	1129	75.1
TxL100212-07-01	5938a-c	1065	72.5
TxL100212-06-06	5789a-c	1014	71.1
TxL100225-03-11	5767a-c	1042	73.5
TxL100225-03-04	5691a-d	1018	72.7
TxL100225-03-02	5611a-d	985	71.2
TxL100225-03-05	5601a-d	1008	72.8
TxL100225-03-06	5525a-d	989	72.6
TxL100225-03-10	5510a-d	982	72.1
TxL100225-03-08	5193b-e	951	74.3
TxL100225-03-07	5183b-e	939	72.6
TxL100225-03-03	5174b-e	880	68.3
TxL100212-07-09	5162b-e	924	72.7
TxL100212-06-04	5148b-e	905	71.0
TxL100212-07-03	5124b-e	935	73.7
TxL100212-07-06	5095b-f	929	73.8
TxL100225-03-09	5011b-f	890	71.9
TxL100212-06-02	4812b-f	863	72.8
TxL100212-05-08	4776b-f	866	73.7
TxL100212-07-02	4682b-f	823	71.5
Tamrun OL11	4635b-f	872	76.1
TxL100212-07-07	4444c-f	793	72.3
TxL100212-07-05	4394c-f	790	72.9
TxL100212-06-07	4145d-f	762	73.8
ICGS-76	4121d-f	759	74.5
TxL100225-03-12	3917ef	706	73.1
TxL100212-07-12	3812ef	672	71.8
TxL100212-05-10	3527f	624	71.7
P-value (≤0.05)	≤0.03	≤0.06	≤0.06

Values followed by the same letter are not significantly different using Fisher's LSD at ($p \leq 0.05$).

Breeding line TxL100225-03-13 had the highest yield at 6914 lbs/a as compared to the commercial check Tamrun OL11 at 4635 lbs/A and the parental check ICGS-76 at 4121 lbs/a. There was no significant difference detected for value/A even though TxL100225-03-13 out-performed Tamrun OL11 by 385$/A due in part to the fact that the grades were also not significant. We hope to find detectable differences for value and %TSMK in the 2018 field trials.

Data for the Drought #3 Trial for South Texas is not shown because the test was not significant. There were lines that performed numerically equal to the Tamrun OL11, but none of the lines performed superior to the checks.

3. Spanish-type Yield Trials

We conducted a 20 entry Spanish-type yield trial at two West Texas locations in 2017. Twelve of the lines performed in the top statistical grouping for yield. TxL076224-24 had the highest mean yield of 5436 lbs/A followed by the commercial check OLin at 5412 lbs/A (**Table 4**). TxL076239-12 had the highest mean value/A at 988$ due in part because it had one of the highest grades in the test at 75.4%. Several of the lines performed equal to or better than the check varieties and will be tested again the 2018 at several locations.

Table 4. Combined Analysis for Two Spanish-type Yield Trials in West Texas during 2017.

Entry	Lbs/A	Value$/A	%TSMK	g/100 seed
TxL076224-24	5436a	976ab	73.7b-f	53.8bc
OLin	5412a	967a-c	73.2c-f	52.4cd
TxL076239-12	5373a	988a	75.4ab	55.6b
TxL076225-48	5306a	948a-e	72.9d-f	51.7c-e
TxL076224-08	5290a	951a-d	73.1c-e	49.8ef
TxL076224-15	5113ab	918a-f	73.5b-f	50.7d-f
Schubert	5066a-c	904a-f	73.1c-f	49.6ef
TxL076229-53	4954a-c	888a-f	73.2c-f	50.7d-f
TxL054520-27	4895a-c	843d-g	70.5g	59.6a
TxL076221-06	4882a-c	883a-f	74.0a-e	48.7f-h
TxL076225-04	4851a-c	875a-f	73.6b-f	46.6h
TxL076226-18	4832a-c	860b-f	72.9d-f	51.6c-e
TxL076225-28	4818a-c	866b-f	73.2c-f	48.9f-h
TxL076225-24	4805a-c	842d-g	71.7fg	50.7d-f
TxL076239-16	4803a-c	850c-f	72.5e-g	55.0b
TxL076221-34	4793a-c	872a-f	74.6a-d	50.1d-f
TxL076236-04	4534cd	826fg	74.8a-d	52.2cd
TxL076239-21	4427cd	827e-g	76.1a	49.0fg
TxL076239-05	3946d	726gh	75.1a-c	47.0gh
TxL076238-16	3899d	703h	73.5b-f	49.1fg
P-value (≤0.05)	≤0.0001	≤0.0003	≤0.0003	≤0.0001

Values followed by the same letter are not significantly different using Fisher's LSD at ($p \leq 0.05$).

4. Quality Analysis

5. Screening for Sclerotinia Disease Resistance

As part of our on-going multiple disease resistant testing the Stephenville location serves as the Sclerotinia screening location. Sclerotinia is a soilborne fungus that is common in many peanut producing areas and severely limits yield when present. All statewide multiple disease resistance trials and earlier generation tests are routinely screened in our nursery on a yearly basis. In 2017, we planted six replicated trials with a total of 1045 one row evaluation plots in late June to allow the plants to still be actively growing as the fall temperatures begin to drop and thus maximize disease pressure. A susceptible variety (Langley) and highly resistant breeding line (Tx901639-3) are used as check varieties to serve as standards for comparison. Plots were cared for according to standard irrigation, weed control and fungicide practices throughout the season.

In late September each plot was inoculated with approximately 35 grams of Sclerotinia inoculum. Following inoculation plots were irrigated nightly as needed to maintain moisture levels that encouraged fungal growth. Following inoculation, a period of cool wet weather allowed disease to begin development, however this was followed by an extended period of hot, dry conditions that caused fungal growth to stop and limiting overall infection. A frost in early November caused further evaluation to be impractical. Plots were rated twice once in mid-October and again in late October for total percent infection on a 0 to 10 scale. O being no infection and 10 being 100% infection.

Overall infection was not as high as in previous years, but differences were observed. Top performers in the Advanced Line Trial for resistance to Sclerotinia were Tx144431 and Tx121032. The average Sclerotinia rating for these two lines was 0.125 and was not statistically different than the resistant breeding line Tx901639-3 as well as Tx121082 (the breeding line that is currently under review for release). In contrast, the susceptible variety Langley had an average Sclerotinia rating of 1.875. Other tests in the field followed a similar pattern with materials earlier in the breeding cycle exhibiting higher disease incidence. Early generation drought populations exhibited the highest disease incidence, which was to be expected since they had never been screened for Sclerotinia resistance.

In addition to screening plots for resistance, a large plot combine trial was conducted in a uninoculated field with mild to moderate Sclerotinia pressure. The trial consisted of 2-row plots which were 200 feet in length and each entry was replicated 4 times. The test included several advanced lines that are currently being considered for release as well as the commercial check Tamrun OL11. Tamrun OL 11 was the highest yielding variety in the trial with an overall yield of 5512 lbs/ac and an average %TSMK of 70.0%. There were two advanced lines Tx1444342 and Tx144370 that performed statistically equal in yield and grade with yields of 5321 and 4918 lbs/ac and grades of 70.0% and 72.6% respectively.

Sub-Project II. Drought, Heat, and Salt Tolerance Breeding

1. **Testing Mini-core for Transpiration Efficiency**
2. **Testing Mini-core for Heat Tolerance**
3. **Crossing Elite Spanish Lines with Drought Tolerant Accessions**
4. **Developing Wild Species Pathway for Introgression of Drought Tolerance**

Development of an introgression pathway was continued using the wild species (*2n-2x=20*) *Arachis dardani* (Krapov. and W.C. Greg.) (GK12946). Crossing programs were conducted in the spring and the fall involving the bridge species *A. vallsii* (Krapov. and W.C.

Greg.) (VSW 9902-1). A total of 101 pollinations were made and 23 seed obtained. Attempts to double chromosome complement to allow hybridization with *Arachis hypogaea* (*2n-4x=40*) are ongoing with promising results.

As part of the same project a transcriptomics analysis of *A. dardani* was conducted using internal funding and has revealed at least 11 candidate genes (Table 1) that represent transcription factors associated with drought. Transcription factors represent genes occurring relatively early in a given genetic pathway and thus represent excellent candidate genes of maximum impact of a given trait. Additional research to validated and develop useful SNP markers will be required.

5. **Testing Peanut for Primed Acclimation to Drought Tolerance**
6. **Salt Tolerance**

Sub-Project III. Marker Assisted Selection and Breeding

1. **Identify Markers for Drought Tolerance in Mini-core**
2. **Continue Screening for Rootknot Nematode Resistance**
   a) We screened 300 individual seeds of breeding line Tx144342 for markers to identify Rootknot nematode resistance. Sixty plants from the original 300 were selected for increase and are now growing as two-row plots which are 10' in length at Pearsall, Texas. We are in the final stages of evaluation to determine whether or not to release this line as a new variety.
3. **Continue Screening for High O/L Trait**
   a) We screened the same 300 individuals mentioned under 2a) above for the high O/L trait. The selections were all high oleic.
4. **Mapping of SNP's in TxAG-6/Florunner Population**
5. **Leafspot Resistant Spanish-types**
6. **Markers for Leafspot Resistance**

Sub-Project IV. SNP Marker Development

1. **Development of a B Genome Mapping Population**
2. **Screen Mini-core with SNP Markers for Association Mapping**
3. **Markers for Nematode Resistance**